INDOOR AIR QUALITY ASSESSMENT

Department of Public Works
Highway Building Garage
33 Lindbergh Ave
Methuen, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
September 2017

BACKGROUND

Building:	Department of Public Works Garage (DPWG)
Address:	33 Lindbergh Ave., Methuen
Assessment Contacts:	Patrick Bower, P.E., Methuen DPW Director & William Depardo, Methuen Health Inspector
Reason for Request:	Referred by Department of Labor Standards (DLS) Re: rodent and sewer odor complaint
Date of Assessment:	8/23/2017
Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Conducting Assessment:	Jason Dustin, Environmental Analyst/Inspector, Indoor Air Quality (IAQ) Program
Date of Building Construction:	1960
Building Description:	Concrete block with pitched asphalt roof over main area
Building Population:	~ 12
Windows:	Openable

METHODS

Please refer to the IAQ Manual and appendices for methods, sampling procedures, and interpretation of results (MDPH, 2015).

RESULTS and DISCUSSION

The following is a summary of indoor air testing results (Table 1).

- ***Carbon dioxide*** levels were below 800 parts per million (ppm) in all areas surveyed, indicating adequate air exchange for the population at the time of assessment.
- ***Temperature*** was within the MDPH recommended range of 70°F to 78°F in occupied areas. Temperatures in the garage were slightly above the recommended range and reflected outside temperatures. The garage bay doors were open at the time of the assessment.
- ***Relative humidity*** was within the MDPH recommended range of 40% to 60% in all areas.

- ***Carbon monoxide*** levels were non-detect (ND). The National Ambient Air Quality Standard (NAAQS) for carbon monoxide is 9 ppm over an 8-hour averaging time and 35 ppm over a 1-hour averaging time. The American Conference of Governmental Industrial Hygienists (ACGIH) industrial (garage) guideline for carbon monoxide is 25 ppm. No vehicles were idling in the garage during air sampling.
- ***Particulate matter (PM2.5)*** concentrations ranged from 16 to 20 $\mu g/m^3$ in the building, which is below the NAAQS of 35 $\mu g/m^{3.}$
- ***Total Volatile Organic Compounds (TVOCs)*** levels were ND.

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 ppm in all areas surveyed. The office area does not appear to have mechanical ventilation to introduce fresh air into the space; heat is provided by an oil-fired boiler connected to steam radiators (Picture 1). Fresh air in the office area is supplied primarily by open windows and infiltration through gaps in the building envelope. Window- mounted air conditioning (AC) units, which supply some fresh air to the space, were operating at the time of the assessment. Setting the AC units to "fan only" would provide fresh, filtered air during temperate weather, but is impractical during the winter months.

The main garage area has several general exhaust fans (Picture 2) that are operated on an as-needed basis. There is a large, fabric "sock-type" make-up air supply duct (Picture 3) to introduce fresh air during the operation of the exhaust fans. Ideally, make-up air supply louvre vents would be sited on the wall opposite the exhaust fans to allow the fan to clear and eject products of combustion from the garage, while the supply vent replaces the ejected air with fresh air. It was reported that DPW staff typically leave the garage doors open to further increase air circulation.

The garage also had spot ventilation for welding activities and vehicle tailpipe exhaust units to remove products of combustion when vehicles are idling indoors. These units are described further below.

Specialized Local Exhaust

Under normal conditions, a garage/public works facility can have several sources of environmental pollutants present from the operation of vehicles. These sources of pollutants can include:

- Vehicle exhaust containing carbon monoxide and soot;
- Vapors from diesel fuel, motor oil, and other vehicle liquids which contain VOCs;
- Water vapor from vehicle washing equipment; and
- Rubber odors from new vehicle tires.

Of particular importance is vehicle exhaust, which is a product of combustion. Local mechanical exhaust ventilation systems are installed in some areas of the garage to remove airborne pollutants (e.g., odors, fumes, carbon monoxide, and other products of combustion) during vehicle idling (Picture 4). The system is designed to collect vehicle exhaust directly at the source and remove it from the building, minimizing exposure. Vehicle idling indoors should be performed only when absolutely necessary/if needed and the tailpipe mechanical exhaust system should be used during vehicle idling.

Of the materials produced by the process of combustion, carbon monoxide can produce immediate, acute health effects upon exposure. The US Environmental Protection Agency (US EOA) has established National Ambient Air Quality Standards (NAAQS) for exposure to carbon monoxide in outdoor air. Carbon monoxide levels in outdoor air must be maintained below 9 ppm over an 8-hour period and below 35 ppm over a 1-hour averaging period in order to meet this standard (US EPA, 2017). Carbon monoxide should not be present in a typical, indoor environment. If it is present, indoor carbon monoxide levels should be less than or equal to outdoor levels. In an industrial setting (e.g., garages, warehouses, shipping/receiving) where carbon monoxide may be a normally occurring pollutant, several work place safety standards exist to reduce exposure. The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) for carbon monoxide is 35 ppm as an 8-hour TWA and 200 ppm as a ceiling (NIOSH, 1992). The American Conference of Governmental Industrial Hygienists (ACGIH) has a carbon monoxide threshold limit value (TLV) of 25 ppm as a TWA for an 8-hour workday and 40-hour workweek (ACGIH, 1994).

Outdoor carbon monoxide measurements were ND. Carbon monoxide levels indoors at the DPWG measured ND to (Table 1). As mentioned, no vehicles were idling and exhaust fans were all operating at the time of the assessment.

Measurement for airborne particulates in combination with carbon monoxide measurements were taken to identify combustion products. The combustion of fossil fuels can produce particulate matter that is of a small diameter (2.5 μm), which can penetrate into the lungs and subsequently cause irritation. For this reason, a device that can measure particulate matter of a diameter of 2.5 μm or less (PM2.5) was used to identify pollutant pathways from vehicles into occupied areas. As mentioned above, PM2.5 particulate measurements in the garage were 20 $\mu m/m^3$ and 16 $\mu m/m^3$, below the NAAQS guideline of 35 $\mu g/m^3$.

Pathways

Pathways for vehicle exhaust and other pollutants to move from bays into adjacent/occupied areas were identified. A gap under the door separating the main garage bay from occupied space was observed. This door, as well as other access points off the mechanic bays, should be kept closed and fitted with weather stripping and door sweeps so that no light is visible around the door edges.

IAQ staff noted several missing or ajar ceiling tiles in the DPW office area (Picture 5). These missing tiles may also serve as a pathway for moisture, odors, and pollutants to enter the office from the garage area.

Microbial/Moisture Concerns

In order for building materials to support mold growth, a source of water exposure is necessary. Factors to consider include:

- DPW garages are normally exposed to moisture from vehicles and activities;
- Most building materials at the DPWG are made from materials that are *not* conducive to mold growth (e.g., concrete walls and flooring);
- Porous items (e.g., ceiling tiles, gypsum wallboard) that become wet and are not dried within 24-48 hours should be discarded and replaced (Picture 6);

- Cardboard boxes and other porous materials were observed directly on the floor of the DPWG (Picture 7). Cardboard boxes and other porous materials should be elevated to prevent wetting from garage activities or condensation, which can lead to water damage and mold growth;
- DPW staff reported that the main garage had a new roof installed approximately five years ago;
- The AC unit in the second floor main office of the old garage appeared to be missing a filter and was occluded with dust (Picture 8). This filter should be replaced to avoid the accumulation of dust and debris in the unit which, together with condensation, has the potential to support microbial growth. AC filters/units should also be cleaned regularly to avoid aerosolizing particulate matter which could serve as a respiratory irritant.

Other concerns

The original DLS referral indicated rodent concerns in the building. Most employees did not report seeing rodents except for those working night shifts. IAQ staff noted the presence of bait stations in the office and garage areas (Picture 9). DPW staff reported that a pest control company provides service approximately every two weeks. DPW staff also reported that plans to increase rodent control are underway. In any pest elimination strategy, it is important to not only bait or trap rodents that get into the building but also seal any pathways, remove areas of harborage, and eliminate food sources. It may be necessary to also close garage doors especially before sunset to prevent easy access for rodent entry into the building. The MDPH recommends the implementation of an Integrated Pest Management (IPM) plan in addition to traditional pest baiting/trapping methods to more effectively control pest issues. The IPM guideline can be found at: http://www.mass.gov/eea/docs/agr/pesticides/publications/ipm-kit-for-bldg-mgrs.pdf.

The original DLS referral also indicated sewer odor concerns in the building. DPW staff interviewed did not report detecting sewer odors in recent memory. There is a pump chamber adjacent to the building that collects sewage from the building and pumps it up to the nearby sewer line at the street. This pump chamber should be inspected periodically to ensure proper function and water tightness. DPW staff are aware of the need to periodically add water to drains and fixtures that are seldom used to prevent dry drain traps. No sewer odors were detected by IAQ staff at the time of this assessment.

Several sections of the DPW garage building are not useable due to structural issues that make these areas unsafe (Picture 10). In addition to safety/moisture concerns, these areas may allow additional harborage for pests. It was reported by DPW staff that they are in the beginning process of designing a new facility to remedy these concerns.

CONCLUSIONS and RECOMMENDATIONS

In view of the findings at the time of the visit, the following recommendations are made:

1. Refrain from idling vehicles indoors unless absolutely necessary. Any idling should be performed utilizing the tailpipe mechanical exhaust systems in the garage.
2. Utilize existing general exhaust ventilation and spot ventilation whenever combustion activities are performed (e.g., vehicle emissions, welding, etc.).
3. Ensure adequate make-up air supply during the use of ventilation systems to effectively clear and eject products of combustion from the garage bays.
4. Keep doors that separate garage bays from office/break areas closed. To prevent products of combustion from entering these occupant areas, install weather stripping and door sweeps so that no light is visible beneath or around the doors.
5. Replace missing ceiling tiles and seal any other gaps or breaches in the shared walls and ceilings between occupant areas and garage bays to avoid the intrusion of particulate matter, odors, and water vapor into occupied areas.
6. Continue with plans to ramp up rodent/pest control efforts at this facility. Consider adopting an IPM plan for more effective pest elimination.
7. Discard water-damaged ceiling tiles found in the office areas and replace with new tiles.
8. Do not store porous materials (e.g., cardboard boxes, paper items) directly on floors; elevate/place on pallets or shelving to prevent water damage and mold growth. Discard any existing water-damaged porous materials.
9. Ensure regular cleaning of Window AC units and filters. Replace filter in AC unit found in office area. These AC units may be set to “fan only” to provide a limited amount of fresh air to office areas.
10. Continue to regularly fill rarely used drains/sinks with water to avoid dry drain traps. Also regularly inspect pump chamber for water tightness and proper function if sewer odors are detected.

11. Continue with plans to design and replace the DPW garage, especially the areas that were deemed to be structurally unsafe and that may be contributing to moisture/pest issues.
12. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritation).
13. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at http://mass.gov/dph/iaq.

REFERENCES

ACGIH. 1994. Threshold limits values for chemical substances and physical agents and biological exposure indices for 1994-1995. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

Massachusetts Department of Public Health (MDPH). 2015. Indoor Air Quality Manual: Chapters I-III. Available at: http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/iaq/iaq-manual/.

NIOSH. 1992. Recommendations for occupational safety and health: Compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 92-100.

US EPA. 2017. National Ambient Air Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. https://www.epa.gov/criteria-air-pollutants/naaqs-table.

Picture 1

Radiator in office area

Picture 2

Exhaust fan in main garage

Picture 3

Fabric “sock-type” make-up air supply duct

Picture 4

Vehicle tailpipe exhaust system

Picture 5

Missing ceiling tiles in office area

Picture 6

Water-damaged ceiling tiles in office area

Picture 7

Various cardboard boxes stored directly on concrete floor

Picture 8

Office AC unit showing dust/debris and missing filter

Picture 9

Rodent bait box in office area

Picture 10

Multiple bays attached to DPWG deemed structurally unsafe

Location: Methuen DPW Highway Bldg Garage

Address: 33 Lindbergh Ave. Methuen, MA

Table 1

Indoor Air Results

Date: 8/23/2017

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (ppm)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Background (outside)	337	ND	81	51	ND	12	-	-	-	-	Clear
Office break area	535	ND	73	49	ND	19	5	Y	N	N	Window AC unit dusty-no filter, rodent bait boxes
Office	662	ND	71	49	ND	20	2	Y	N	N	Window AC unit, missing/ajar ceiling tiles, WD ceiling tiles
Main garage area	387	ND	79	57	ND	20	6	Y	N	Y	Multiple general exhaust fans, vehicle tailpipe exhaust systems, spot welding exhaust, "sock" make-up air duct, steam heat, cardboard on floor, garage doors open, no vehicles idling
Small garage bays	365	ND	80	55	ND	16	4	Y	N	N	General exhaust, garage doors open, tires, solvents

ppm = parts per million ND = non detect AC = window air conditioner WD = water-damaged

µg/m^3 = micrograms per cubic meter

Comfort Guidelines

Carbon Dioxide:	< 800 ppm = preferred	Temperature:	70 - 78 °F
	> 800 ppm = indicative of ventilation problems	Relative Humidity:	40 - 60%